From	To	Multiply By

5.1 Quantities of Space and Time

5.1.1 *Plane angle*

NOTE: No change in U.S. customary usage is required for plane angle units. The **radian**, which is the SI unit, is most frequently used in scientific or technical work and in forming derived units. Use of the degree and its decimal fractions is permissible. Use of the minute and second is discouraged except for specialized fields such as cartography.

5.1.2 *Solid angle*

NOTE: No change in U.S. customary usage is required for solid angle units. The **steradian**, which is the only unit commonly used to express solid angle, is an SI unit.

5.1.3 *Length*

ångström	**nanometer (nm)**	**0.1**
fathom	**meter (m)**	**1.828 8**
foot	**meter (m)**	**0.304 8**
foot [U.S. survey]	**meter (m)**	0.304 800 6

NOTE: In 1893 the U.S. foot was legally defined as 1200/3937 meters. In 1959 a refinement was made to bring the foot into agreement with the definition used in other countries, i.e. 0.3048 meters. At the same time it was decided that any data in feet derived from and published as a result of geodetic surveys within the U.S. would remain with the old standard, which is named the U.S. survey foot. The new length is shorter by exactly two parts in a million. The five-digit multipliers given in this standard for acre and acre-foot are correct for either the U.S. survey foot or the foot of 0.3048 meters exactly. Other lengths, areas, and volumes are based on the foot of 0.3048 meters.

inch	**centimeter (cm)** **millimeter (mm)**	**2.54** **25.4**
microinch	**micrometer (μm)**	**0.025 4**
mil	**millimeter (mm)** **micrometer (μm)**	**0.025 4** **25.4**
yard	**meter (m)**	**0.914 4**
mile	**kilometer (km)**	**1.609 344**

From	To	Multiply By
5.1.3 *Length* (continued)		
nautical mile	**kilometer (km)**	**1.852**
NOTE: The nautical mile is an accepted unit for use in navigation.		
point	**millimeter (mm)**	0.351 46
pica	**millimeter (mm)**	4.217 5
5.1.4 *Area*		
acre	**square meter (m^2)**	4 046.9
	hectare (ha)	0.404 69
NOTE: The hectare, equal to 10 000 m^2, is accepted for use with SI.		
circular mil	**square millimeter (mm^2)**	0.000 506 708
square inch	**square centimeter (cm^2)**	**6.451 6**
	square millimeter (mm^2)	**645.16**
square foot	**square meter (m^2)**	**0.092 903 04**
square yard	**square meter (m^2)**	0.836 127 4
square mile	**square kilometer (km^2)**	2.589 988
5.1.5 *Volume*		
acre-foot	**cubic meter (m^3)**	1 233.5
barrel, oil	**cubic meter (m^3)**	0.158 987 3
(42 U.S. gallons)	liter (L)	158.987 3
NOTES: (1) The liter, equal to 0.001 m^3, is accepted for use with SI. (2) A variety of barrel sizes have been used for other commodities.		
cubic yard	**cubic meter (m^3)**	0.764 555
cubic foot	**cubic meter (m^3)**	0.028 316 85
	liter (L)	28.316 85
board foot	**cubic meter (m^3)**	0.002 359 737

From	To	Multiply By

5.1.5 *Volume* (continued)

register ton	**cubic meter (m^3)**	2.831 685

NOTE: The register ton is a unit of volume used to express the capacity of a ship. For example, a 20 000 ton freighter has a capacity of approximately 57 000 m^3, measured in accordance with established procedures.

bushel	**cubic meter (m^3)**	0.035 239 07

NOTE: Agricultural products that are sold by the bushel in the United States are often sold by weight in other countries. There can be a considerable variation in the weight per unit volume due to differences in variety, size, or condition of the commodity, tightness of pack, degree to which the container is heaped, etc. The following conversion factors are used by the U.S. Department of Agriculture for statistical purposes:

Crop	Weight per bushel (kg)
barley	21.8
corn, shelled	25.4
oats	14.5
potatoes, soybeans, wheat	27.2

gallon	liter (L)	3.785 412
quart (liquid)	liter (L)	0.946 352 9
pint (liquid)	liter (L)	0.473 176 5
fluid ounce	milliliter (mL)	29.573 53

NOTE: In the United States, the cup, tablespoon, and teaspoon are defined as 8, 1/2, and 1/6 fluid ounces, respectively. Forpractical usage the metric equivalents are 250 mL, 15 mL, and 5 mL.

cubic inch	**cubic centimeter (cm^3)**	16.387 06

5.1.6 *Time*

NOTE: No change in customary U.S. usage is required for time units. The **second** is the SI unit of time, but the minute and hour, as well as the day, week, year, etc., are accepted units.

5.1.7 *Velocity*

foot per second	**meter per second (m/s)**	**0.304 8**
mile per hour	kilometer per hour (km/h)	1.609 3
knot	kilometer per hour (km/h)	**1.852**

NOTE: The knot, or nautical mile per hour, is an accepted unit for use in navigation.

From	To	Multiply By
5.1.8 *Acceleration*		
inch per second squared	**meter per second squared (m/s^2)**	**0.025 4**
foot per second squared	**meter per second squared (m/s^2)**	**0.304 8**
standard acceleration of gravity (*g*)	**meter per second squared (m/s^2)**	**9.806 65**
5.1.9 *Flow rate*		
cubic foot per second	**cubic meter per second (m^3/s)**	0.028 316 85
cubic foot per minute	**cubic meter per second (m^3/s)** liter per second (L/s)	0.000 471 947 0.471 947 4
cubic yard per minute	liter per second (L/s)	12.742 58
gallon per minute	liter per second (L/s)	0.063 090 2
gallon per day	liter per day (L/d)	3.785 412
5.1.10 *Fuel efficiency*		
mile per gallon	kilometer per liter (km/L)	0.425 143 7

NOTE: To convert fuel efficiency in miles per gallon to fuel consumption in liters per 100 kilometers, use the formula:

$$\frac{235.2}{\text{number of miles per gallon}} = \text{number of liters per 100 kilometers}$$

5.2 Quantities of Mechanics

5.2.1 *Mass (weight)*

NOTE: There is ambiguity in the use of the term "weight" to mean either *force* or *mass*. In general usage, the term "weight" nearly always means *mass* and this is the meaning given the term in U.S. laws and regulations. Where the term is so used, weight is expressed in **kilograms** in SI. In many fields of science and technology the term "weight" is defined as the *force* of gravity acting on an object, i.e., as the product of the *mass* of the object and the local acceleration of gravity. Where weight is so defined, it is expressed in **newtons** in SI.

ton (long)	**kilogram (kg)**	1 016.047
	metric ton (t)	1.016 047

NOTE: The metric ton (referred to as "tonne" in many countries), equal to 1000 kg, is accepted for use with SI.

From	To	Multiply By
5.2.1 *Mass (weight)* (continued)		
ton (short)	**kilogram (kg)**	**907.184 74**
	metric ton (t)	0.907 184 7
slug	**kilogram (kg)**	14.593 90
pound	**kilogram (kg)**	**0.453 592 37**
ounce, troy	**gram (g)**	31.103 48
ounce, avoirdupois	**gram (g)**	28.349 52
grain	**milligram (mg)**	64.798 91
5.2.2 *Moment of mass*		
pound foot	**kilogram meter (kg·m)**	0.138 255 0
5.2.3 *Density*		
ton (short) per cubic yard	**kilogram per cubic meter (kg/m^3)**	1 186.553
	metric ton per cubic meter (t/m^3)	1.186 553
pound per cubic foot	**kilogram per cubic meter (kg/m^3)**	16.018 46
5.2.4 *Concentration (mass)*		
pound per gallon	gram per liter (g/L)	119.826 4
ounce per gallon	gram per liter (g/L)	7.489 152
5.2.5 *Momentum*		
pound foot per second	**kilogram meter per second (kg·m/s)**	0.138 255 0
5.2.6 *Moment of inertia*		
pound square foot	**kilogram square meter ($kg·m^2$)**	0.042 140 11
5.2.7 *Force*		
pound-force	**newton (N)**	4.448 222
poundal	**newton (N)**	0.138 255 0

From	To	Multiply By

5.2.8 *Moment of force, torque*

pound-force foot	**newton meter (N·m)**	1.355 818
pound-force inch	**newton meter (N·m)**	0.112 984 8

5.2.9 *Pressure, stress*

standard atmosphere	**kilopascal (kPa)**	**101.325**

NOTE: The SI unit for pressure and stress is the **pascal**, which is equal to the newton per square meter. This unit, its multiples, and submultiples are preferred for all applications.

bar	**kilopascal (kPa)**	**100**

NOTE: The bar and its submultiples are accepted for limited use in meteorology only. It is not accepted for use in the U.S. for other applications, e.g., as the unit of fluid pressure in pipes and containers. The appropriate SI multiples, e.g., **kilopascal** or **megapascal**, should be used instead.

millibar	**kilopascal (kPa)**	**0.1**
pound-force per square inch	**kilopascal (kPa)**	6.894 757
kilopound-force per square inch	**megapascal (MPa)**	6.894 757
pound-force per square foot	**kilopascal (kPa)**	0.047 880 26
inch of mercury	**kilopascal (kPa)**	3.386 38
foot of water	**kilopascal (kPa)**	2.988 98
inch of water	**kilopascal (kPa)**	0.248 84
millimeter of mercury	**kilopascal (kPa)**	0.133 322 4

NOTE: The actual pressure corresponding to the height of a vertical column of fluid depends upon the local acceleration of gravity and the density of the fluid, which in turn depends upon the temperature. The conversion factors given here are conventional values adopted by the International Organization for Standardization (ISO).

torr	**pascal (Pa)**	133.322 4

5.2.10 *Viscosity (dynamic)*

centipoise	**millipascal second (mPa·s)**	**1**